UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
AND COMPUTER SCIENCES

BERKELEY, CALIFORNIA 94720

19 August, 1992

Dr. Teresa McMullen
800 North Quincy Street
Code 1142PS
Room 823
Division of Cognitive Neurological Sciences
Office of Naval Research
Arlington, VA 22217

Dear Dr. McMullen,

This is our semiannual report of activity on Grant N00014-91-J-1333 during the period is 1 Jan 92 through 30 Jun 92.

The personnel working on project N00014-91-J-1333 during the reporting period were E.R. Lewis (PI), B.H. Bonham (doctoral student, research assistant) and B.R. Parnas (doctoral student, research assistant). During this period our efforts have focused on sections III and IV.B of the original proposal, auditory model system considerations and activity-driven self-organization, respectively. Mr. Parnas has been continuing development of the model to be used for spike initiation and integration of this model into structures which present images of auditory space. Mr. Bonham has extended his self-organization work to the cochlear nucleus, the last purely monaural brainstem processing center.

Software development over the past six months included the following steps: (1) Further refinement and evaluation of the spike initiator model. (2) Improvement of the graphical display function of the auditory system modeling package. (3) Exploration of the effects of neuronal modeling parameters on the images generated by the VIIIth nerve (4) Development of models for the MSO and evaluation of spike synchrony models for the vestibular system. (5) Analysis of a model for activity-driven self-development of the cochlear nucleus. (6) Development of improved cochlear filter banks, some based on data from gerbil REVCOR experiments.

In an effort to capture the relevant properties of biological neuronal processing without incurring a large time penalty in simulation the spike initiator model has been improved to reflect

the behavior seen in physiological recordings from mammalian preparations. This improvement does not result in any additional processing time penalty. A portion of the graphical system enhancements in step (2) were displayed at the Progress Report meeting in April. The goal of this portion of the work has been to present the user with a data representation that exploits the ability of humans to process and interpret data presented visually. The form of the data in these displays leads to concepts for processing algorithms at the next level. In a parallel effort, step (3) involved evaluation of the effects of neuronal modeling parameters on the form of the graphical data representation. This will be used to devise displays that present the information in the most useful manner. The spike initiators have been used to explore real problems such as binaural sound localization based on interaural time difference and the detection of transient events in the vestibular system by examining synchrony of spike firing. The maps generated from the MSO comprise a set of images of frequency vs. interaural time delay, a new image generated at each timestep. This is represented as a family of graphs at selected time points during the simulation displaying time shifts within different frequency bands.

The receptive field of a cochlear nucleus unit can be described in terms of its frequency tuning curve (FTC), or frequency response at different stimulus amplitudes. Cochlear nucleus cell FTCs have been categorized into four classes [1] (Fig. 1), and with appropriate choice of parameters, our developmental model was able to recreate all of these response types for model cochlear nucleus cells, step (5). Task (6), development of improved filter functions for the cochlear module is ongoing. We have developed a module based on the REVCOR responses of gerbil auditory filters. In addition, Mr. Bonham has developed a modeled filter bank with steep high-frequency cutoff and gradual low-frequency rolloff which does not suffer from unrealistically long delays from one end of the cochlea to the other.

During the coming period, we plan to improve the module for the MSO, develop a model for the LSO and to further improve and examine our spectrographic maps (i.e., those from the various modules) in groups, in order to gain intuition about how they might be integrated to yield sound source segregation. Ongoing work includes this analysis of the origin of developed properties, and application of the development model to higher auditory brainstem centers, including specifically the superior olivary nuclei.

Sincerely yours,

Edwin R. Lewis

Edwin R. Lewis

Bibliography:

[1] E. Young, W. Schofner, J. White, J. Robert, & H. Voigt, Response properties of cochlear

nucleus neurons in relationship to physiological mechanisms, in: Auditory Function: Neurobiological Bases of Hearing, edited by G. Edelman, W. Gall, & W. Cowan. New York: Wiley, 1988.

Publications:

B. Bonham, A model for activity-driven development of auditory receptive fields, Proceedings of the 14th Conference of the IEEE/EMBS (in press).

B.R. Parnas and E.R. Lewis (1993), A *neuronal modeling system for generating brainstem maps* of auditory space, in Computational Neural Systems II, F.H. Eeckman, ed., Kluwer Academic Publishers, Norwell, MA. (In Press)

E.R. Lewis and B.R. Parnas, Theoretical bases of short latency spike volleys in the peripheral auditory system. Submitted to Vestibular Research (invited paper at NIH Workshop on Vestibular Evoked Responses).

cc: Administrative Grants Officer
Director, Naval Research Laboratory
Defense Technical Information Center